The Preservation of Possible Martian Life

Mark Lupisella
NASA/Goddard Space Flight Center
Greenbelt Road
Greenbelt, MD 20770
Code 584
(301) 286-2918
Mark.Lupisella@gsfc.nasa.gov

As we expand our presence in the solar system and beyond, novel and challenging scientific and policy issues will face us. A relatively near-term issue requiring attention involves questions regarding the search for and discovery of primitive extraterrestrial life—Mars being an obvious candidate. Such a search and potential discovery is clearly of paramount importance for science and will pose unique mission planning and policy questions regarding how we should search for and interact with that life. This paper will explore the scientific, mission planning, and policy issues associated with the search and interaction with possible primitive extraterrestrial life.

Some of the questions to be considered are: Could contamination compromise possible indigenous life forms? To what extent can we control contamination? (e.g. will it be local or global?) What are the criteria for determining the biological status of a locale, or of the entire planet? (e.g. can we extrapolate from a few strategic missions, or will it take many precursor missions of diverse life-detection capability?) What should our policies be regarding our interaction with primitive forms of extraterrestrial life?

Central to the science and mission planning issues is the role and feasibility of modeling techniques and the possibilities for a high number of appropriate precursor missions. (e.g. a large number of small robotic explorers could be used to effectively and inexpensively assess the biological status of a locale, or of an entire planet such as Mars?) Central to many of the policy aspects are issues of value. Exploring this overall issue responsibly requires a holistic understanding of how both of these aspects interrelate.

"Life" Looking for Life

Mark Lupisella

NASA/Goddard Space Flight Center
Greenbelt MD, 20771

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Life-Detecting Biomorphs

- How do we assess the biological status of locales and planets?
  - If we think we need many diverse missions and samples, we will want comprehensive, efficient, inexpensive, life-detection coverage. Perhaps biomorphis can do this. Perhaps they can be designed to detect organics, metabolism, nucleic acids, spores, chirality, negentropism, etc., or to perform epiflourescence microscopy, molecular sequencing, culturing, etc.
  - It's hard to know what to look for when looking for extraterrestrial life. Cooperative robotics may help by allowing a kind of "shotgun" approach. Many different kinds of life-detection devices can be sent on many different kinds of robots that would need to communicate with each other (perhaps chemically? - in keeping with the biological theme) so as to facilitate efficient collective analysis. For example, if a gas-chromatograph mass spectrometer robot senses organics, it may request the assistance of a metabolism based life-detection robot. In general, biologically inspired exploration methodologies should be considered.
  - However, range may be an issue. Flying, hopping, rolling, swimming may help. Perhaps follow-on robots could be precisely deployed (e.g. perhaps via a beacon mechanism) from an orbiting vehicle so as to avoid traversing large distances. Or perhaps biomorphs need not necessarily be small. There are large terrestrial creatures, so why not biomorphs? An ostrich (perhaps with four legs) may be a good example – long neck for navigation, large body for life-detection payloads, and long legs (perhaps with ingeniously designed wheels as feet that can be locked for walking, or used for rolling over smooth surfaces so as to cover larger distances more efficiently.) Power is always a constraint and would probably be even more so with larger robots. Power stations may help for recharging or perhaps for "remote" power in the form of laser transmission, for example.
  - The issue of assessing the biological status of locales and planets may be critical for preparing human mission planning and preparation. It may also be very important for in situ human activity (e.g. remote robotic reconnaissance.)
- Does sending a large number of robots present contamination or more general environmental/ecological concerns? Can biomorphic life-detection robots be sterilized so as to avoid false-positives and contamination for future missions?